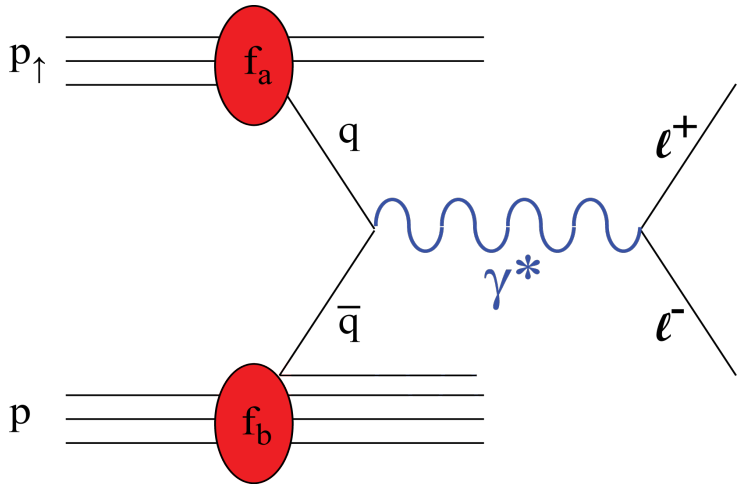
A_NDY status and plans



Xuan Li

(Shandong Uni. & BNL)

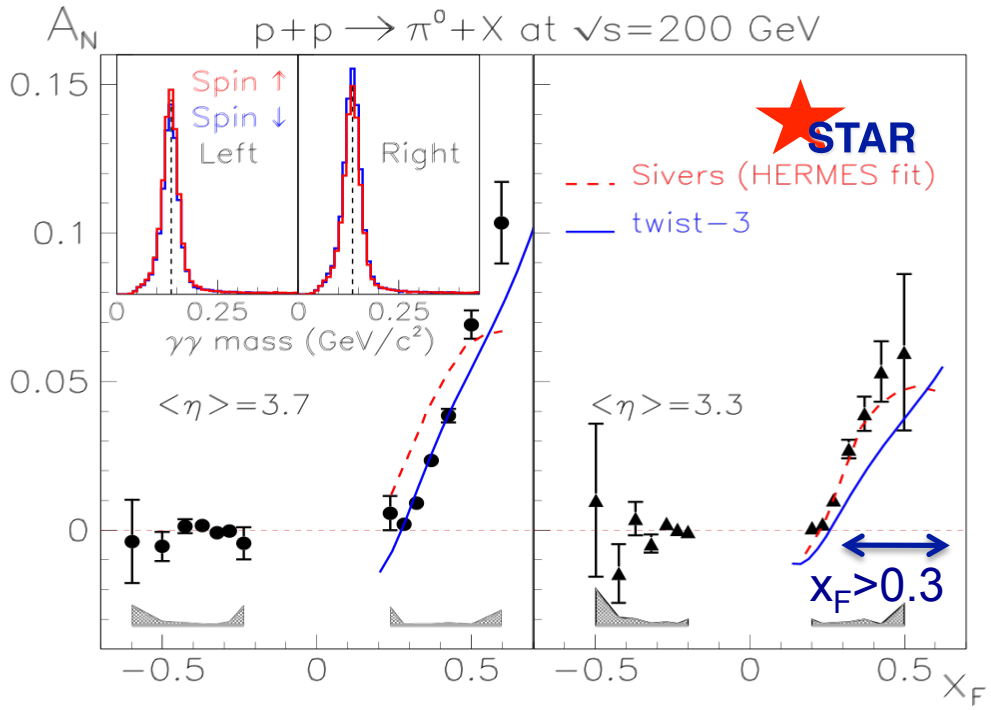
RHIC&AGS Users Meeting, June 20, 2011

Outline

- Motivation
- Run11 configuration and preliminary results
- Run12 plan
- Summary and outlook

Motivation

- Transverse spin asymmetry measured at RHIC



B.I. Abelev et al., Phys. Rev. Lef. 101 (2008) 222001

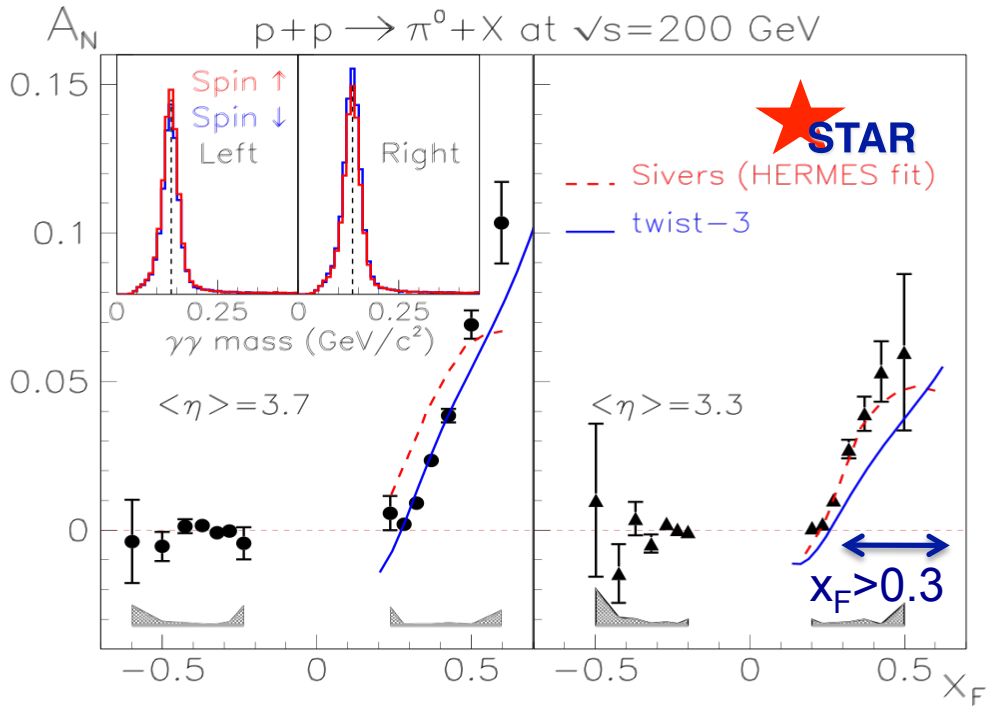
U. D'Alesio, F. Murgia
Phys. Rev. D 70, 074009 (2004)
arXiv:hep-ph/0712.4240

C. Kouvaris, J. Qiu, W. Vogelsang, F. Yuan,
Phys. Rev. D 74, 114013 (2006).

Fits to SIDIS (HERMES) are consistent with p+p $\longrightarrow \pi^0$+X data.

Motivation

- Transverse spin asymmetry measured at RHIC



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Phys. Rev. D 70, 074009 (2004)
arXiv:hep-ph/0712.4240

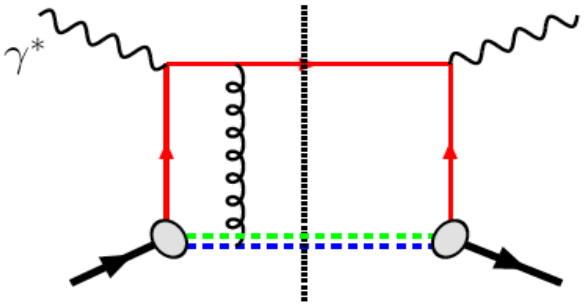
C. Kouvaris, J. Qiu, W. Vogelsang, F. Yuan,
Phys. Rev. D 74, 114013 (2006).

As the x range don't overlap, fits to SIDIS (HERMES) were consistent with p+p⟶ π^0+X data.

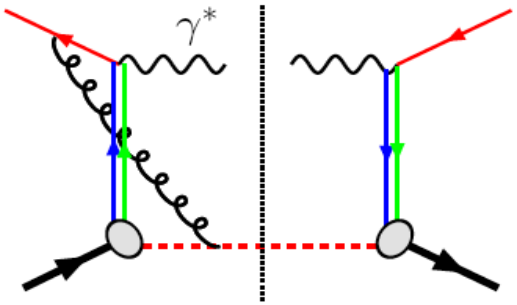
Theory prediction for Drell-Yan process

- Sivers function: $\hat{S}_T \bullet \left(\hat{P} \times \hat{k}_\perp\right) f_{1T}^{\perp}(x, k_\perp)$
- In QCD

DIS: attractive



Drell-Yan: repulsive



As a result:

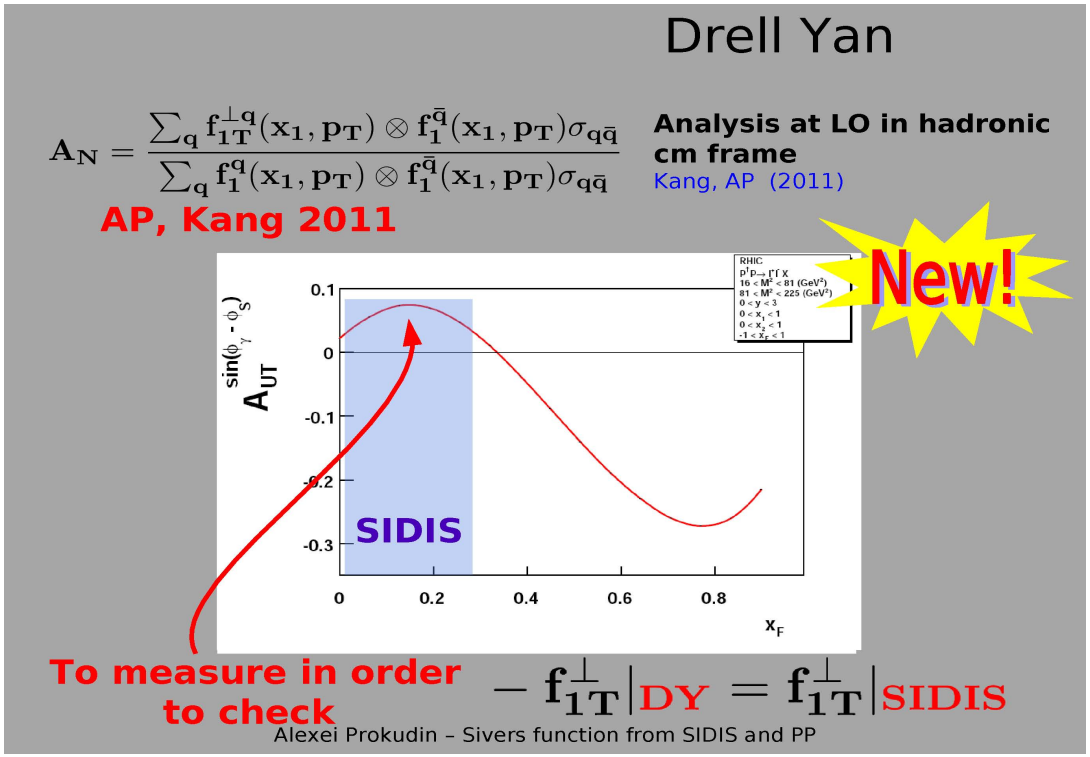
$$\text{Sivers}|_{\text{DIS}} = -\text{Sivers}|_{\text{DY}}$$

Theory prediction for Drell-Yan process

- New development

•SIDIS and RHIC pion production do not overlap in momentum fraction (x)

•Attempts to describe both results in a sign "mismatch" conclusion (Kang, Qiu, Vogelsang, Yuan PRD83 (2011) 094001



Combined analysis of SIDIS and RHIC pion production leads to the conclusion that the u-quark Sivers function has a node at x~0.4

A. Prokudin, Z.B. Kang "Opportunities for Drell-Yan Physics at RHIC" workshop (May, 2011)

Essential to test Dell-Yan process in this region

Motivation

- A_NDY: to measure analyzing power for Drell-Yan process.
- Goals of A_NDY:
  - Demonstrate that large-x_F low-mass dileptons from the Drell-Yan process can be discriminated from background in $\sqrt{s}$=500 GeV $p^{\uparrow}$+p collisions.
  - Measure the analyzing power for Drell-Yan production with sufficient statistical precision to test the theoretical prediction of a sign change for DY in relation to semi-inclusive deep inelastic scattering.
  - Concurrent measurement of π^0 or jet analyzing power.
  - Establish if robust detection of Drell-Yan dileptons at large x_F and low mass requires magnetic analysis $\Rightarrow$ critical for future facilities at RHIC.

A_NDY collaboration

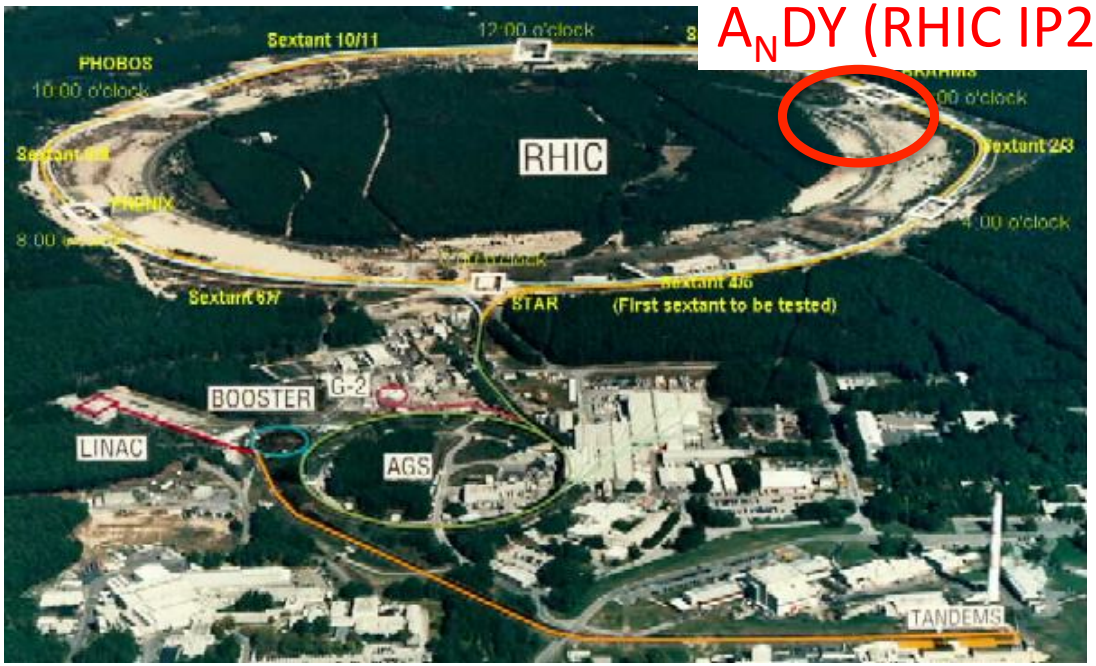
Proposal sent to PAC and get approval on 20110607.

New collaborators join in RHIC activities from JLAB and HERMES.

E.C.Aschenauer, A. Bazilevsky, L.C. Bland, K. Drees, C. Folz, Y. Makdisi, A. Ogawa, P. Pile, T.G. Throwe
Brookhaven National Laboratory
H.J. Crawford, J.M. Engelage, E.G. Judd
University of. California, Berkeley/Space Sciences Laboratory
C.W. Perkins
University of. California, Berkeley/Space Sciences Laboratory /Stony Brook University
A. Derevshchikov, N. Minaev, D. Morozov, L.V. Nogach
Institute for High Energy Physics, Protvino
G. Igo
University of California, Los Angeles
M. Grosse Perdekamp
University of Illinois
M.X. Liu
Los Alamos National Laboratory
H. Avakian
Thomas Jefferson National Accelerator Facility
E.J.Brash
Christopher Newport University and TJNAF
C.F.Perdrisat
College of William and Mary
V. Punjabi
Norfolk State University
Li, Xuan
Shandong University, China
Mirko Planinic, Goran Simatovic
University of Zagreb, Croatia
A. Vossen
Indiana University
G. Schnell
University of the Basque Country and IKERBASQUE,Spain
A. Shahinyan, S. Abrahamyan
Yerevan Physics Institute

A_NDY Run11 configuration

- Where is A_NDY



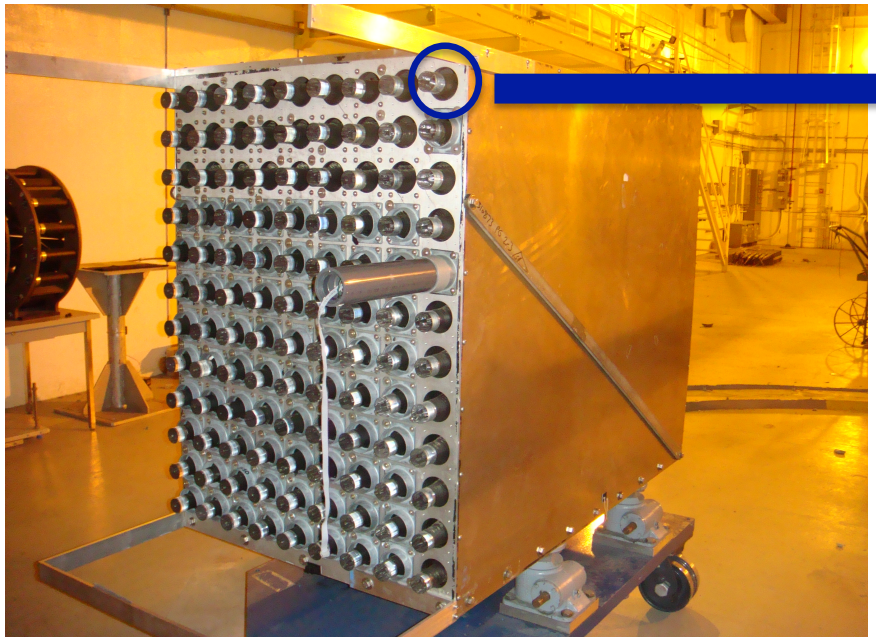
Run11 goals:

(1) Establish the impact of a third IR on RHIC performance for p+p collisions at √s=500 GeV.

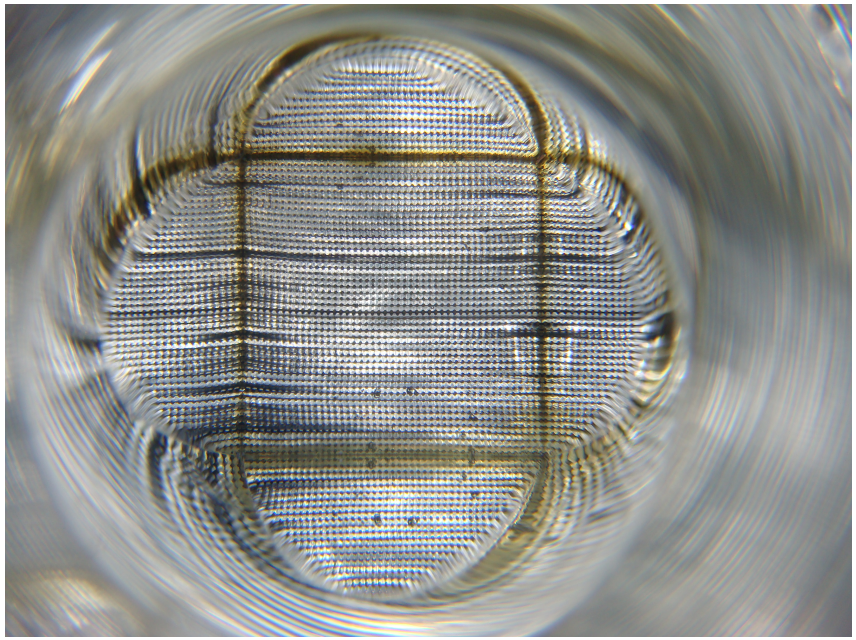
(2) Demonstrate calibration of hadronic calorimeter.

A_NDY building process

- Aug. 2010 to Jan. 2011



One 9x12 hadronic calorimeter module (originally from AGS E864, and later also used in PHOBOS) from PMT side.

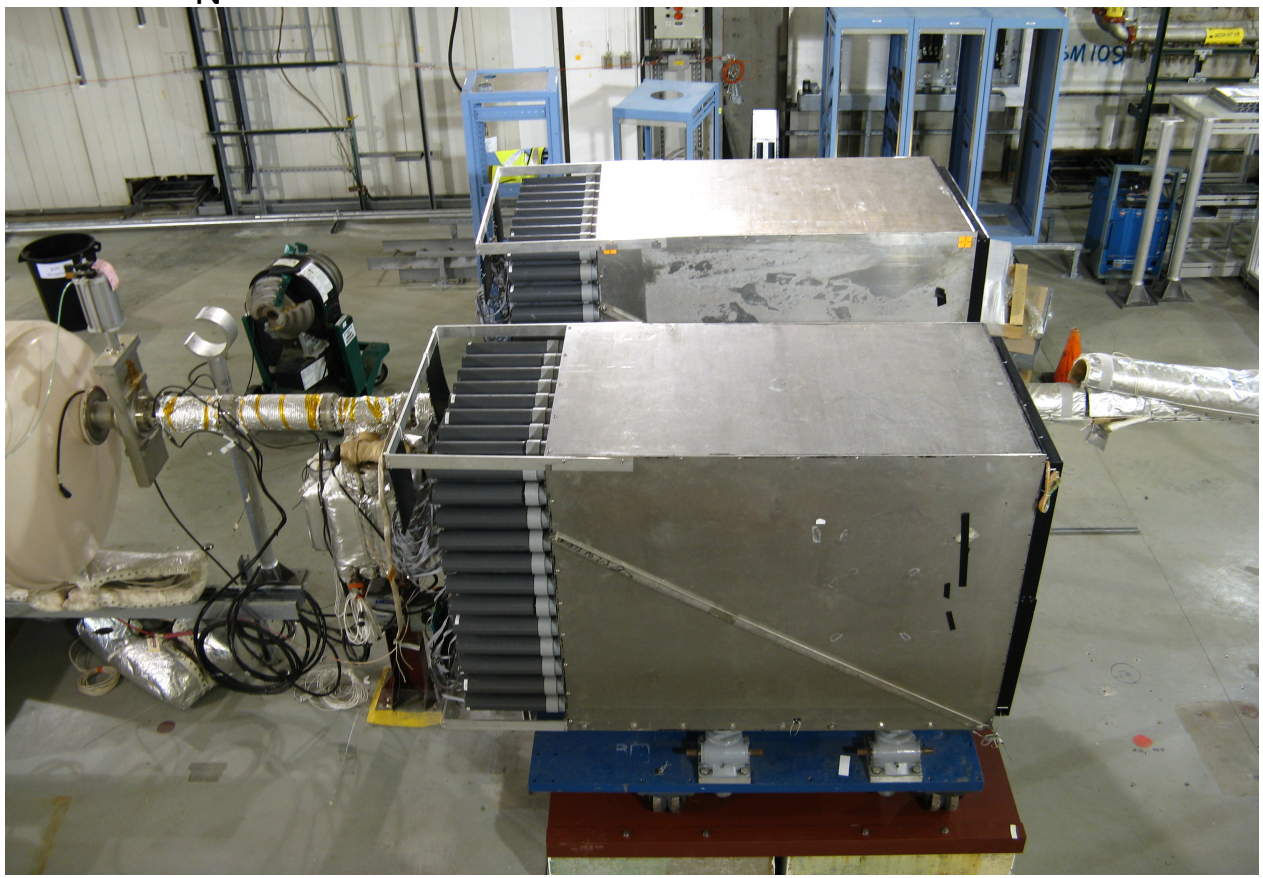


Front view of one hadronic calorimeter cell. 47x47 scintillation fiber embedded in lead for each cell.

A_NDY building process

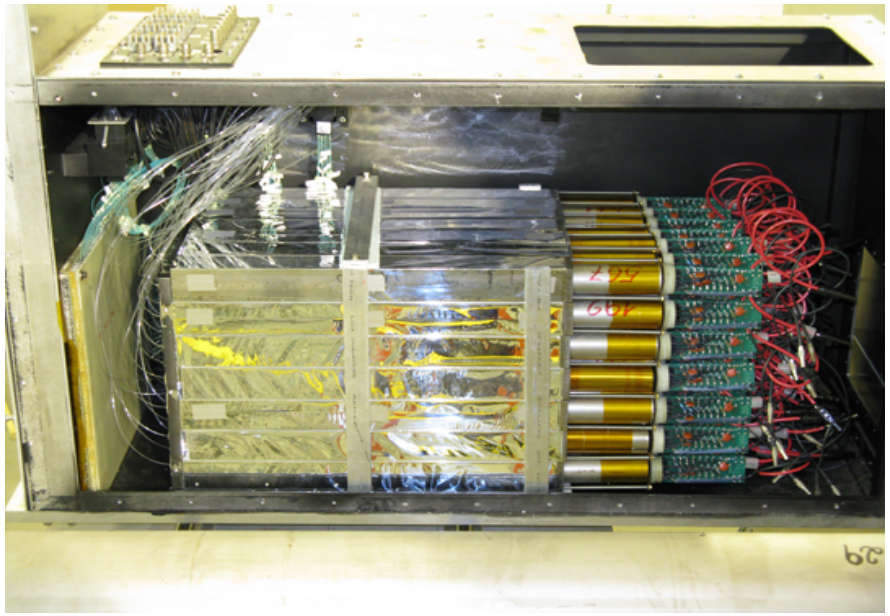
- Aug. 2010 to Jan. 2011

  Two 9x12 Pb-scintillation hadronic calorimeters are installed at A_NDY.

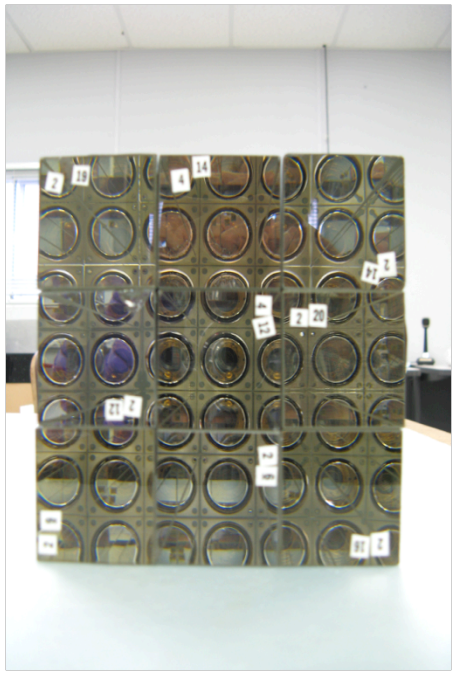


A_NDY building process

- Aug. 2010 to Jan. 2011



One module of 7x7 Pb-glass electromagnetic calorimeter (borrowed from JLAB "BigCal").

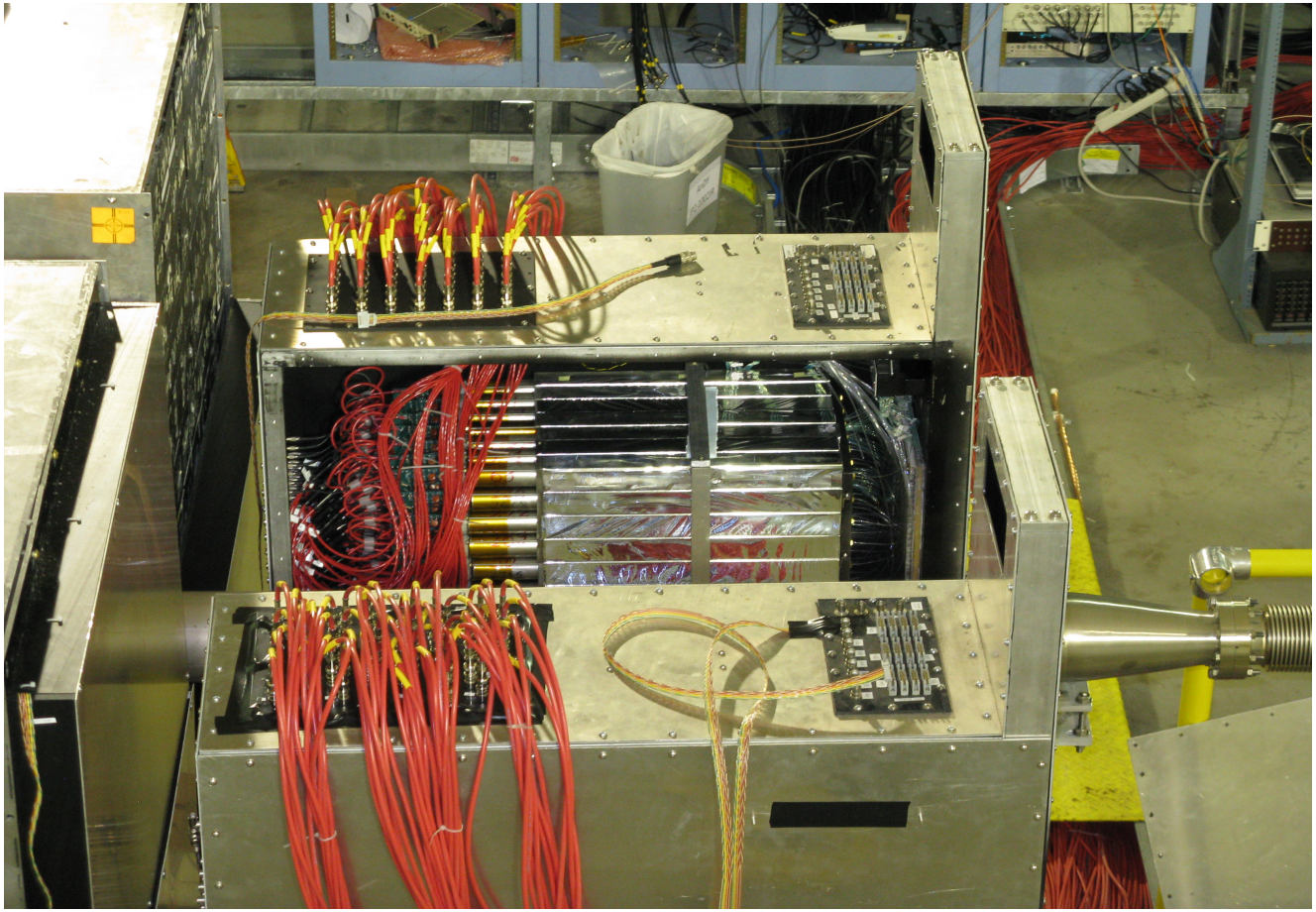


3x3 test stack of EM calorimeter

A_NDY building process

- Aug. 2010 to Jan. 2011

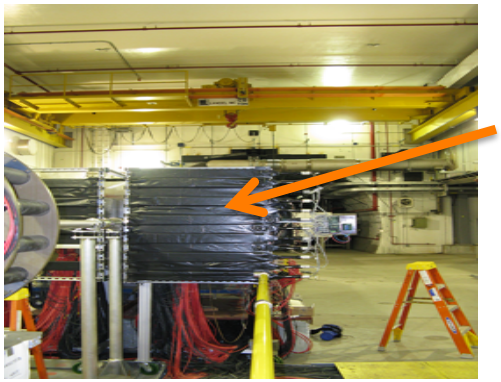
Two 7x7 Pb-glass EM calorimeters are installed at A_NDY



A_NDY building process

- Aug. 2010 to Jan. 2011

Preshower 1 detector (beam right side) before EMcal and Hcal.



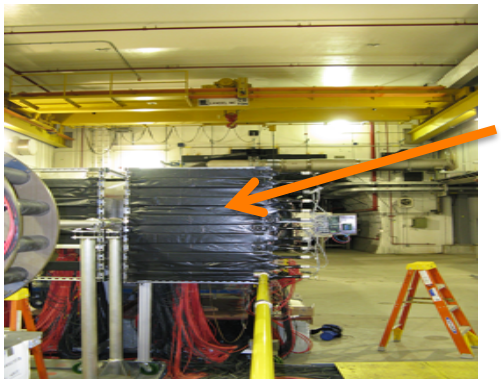
Preshower 2 detector (beam right side) before Preshower 1 detector.

A_NDY building process

- Aug. 2010 to Jan. 2011

Beam Beam Counter (BBC) was used in PHOBOS.

Preshower 1 detector (beam right side) before EMcal and Hcal.



Preshower 2 detector (beam right side) before Preshower 1 detector.

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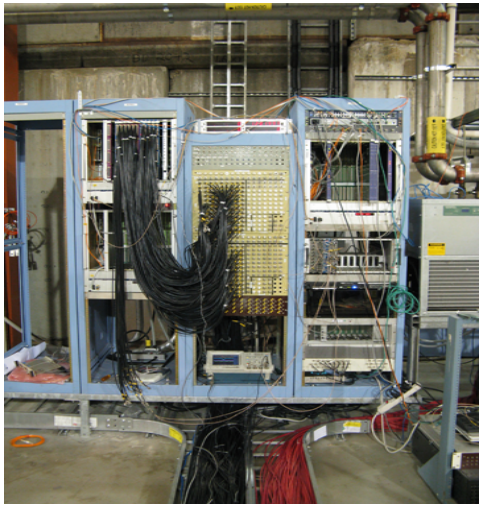
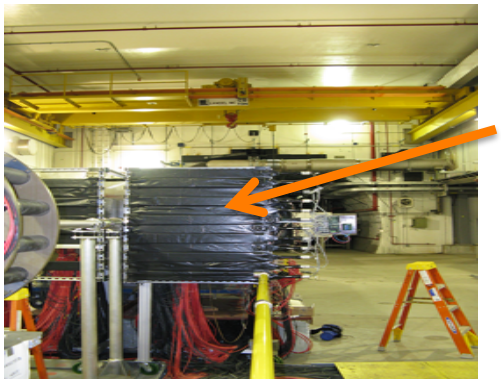


Electronic readout, trigger and data acquisition racks.

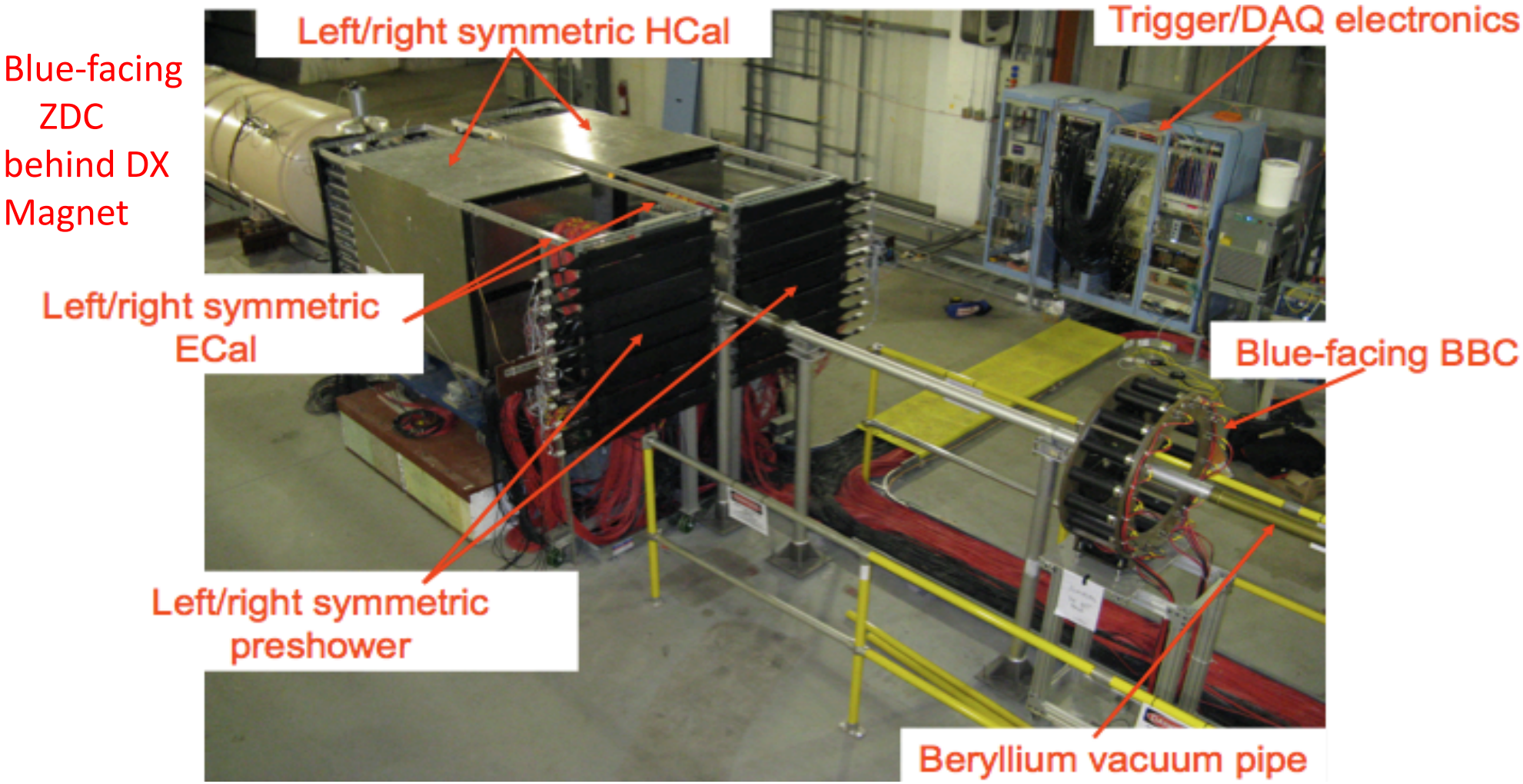
Preshower 1 detector (beam right side) before EMcal and Hcal.



Preshower 2 detector (beam right side) before Preshower 1 detector.

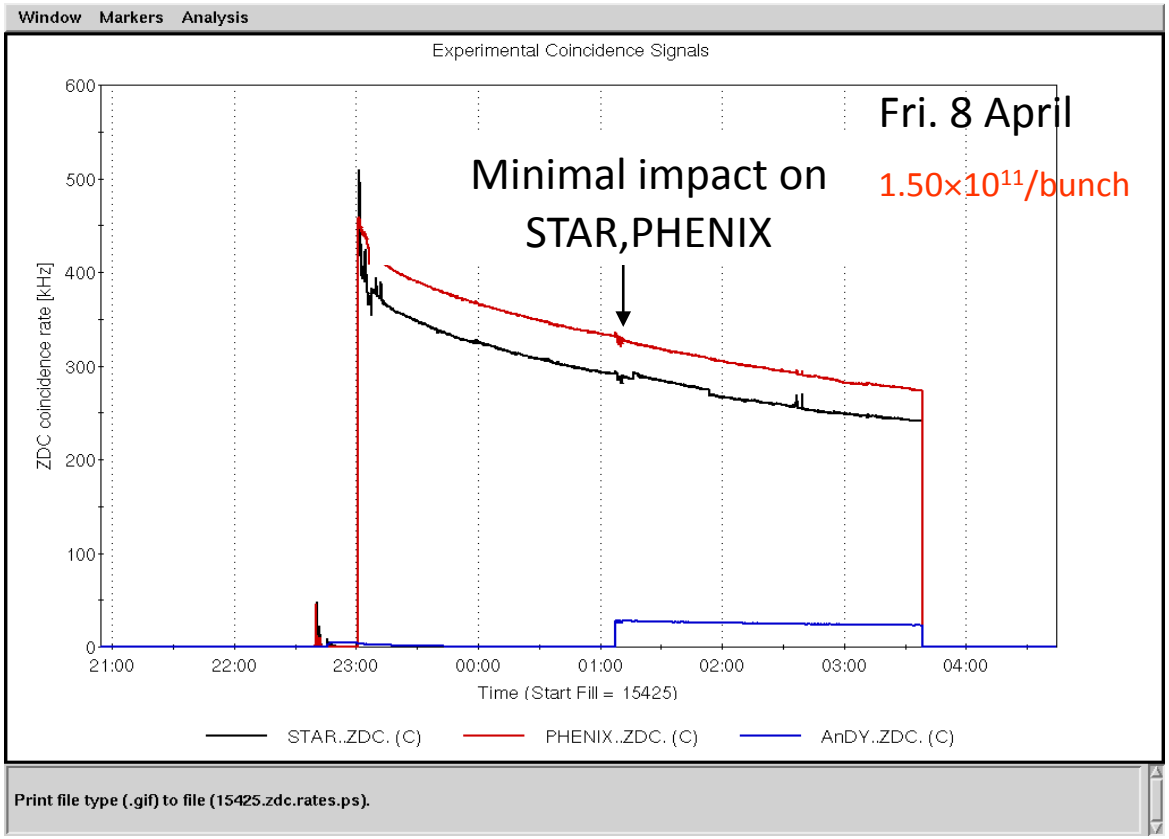
A_NDY Run11 configuration

- Jan. 2011



What we get from Run11

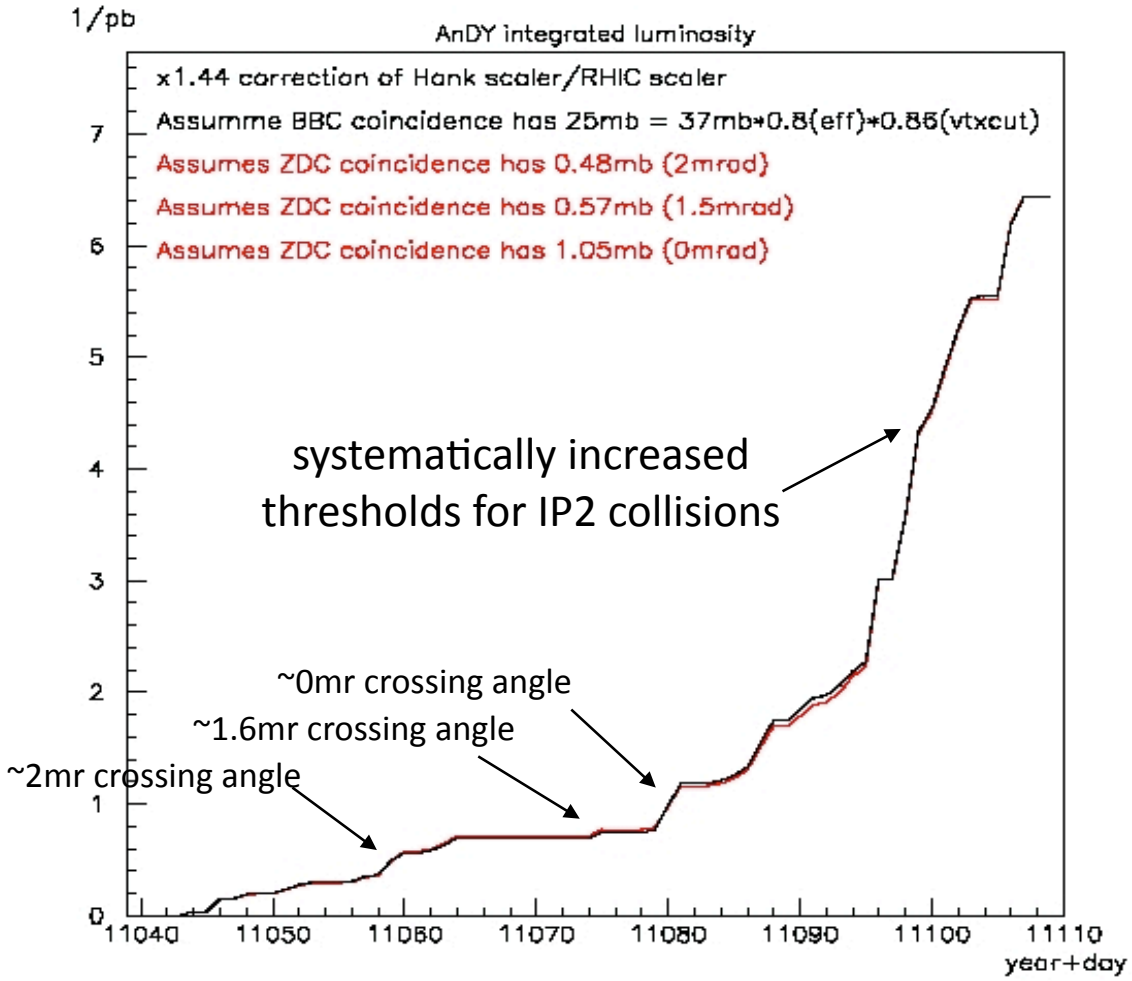
- Impact on STAR and PHENIX



IP2 collisions have begun <3 hours after physics ON with minimal impact on IP6,IP8

What we get from Run11

- Run11 luminosity

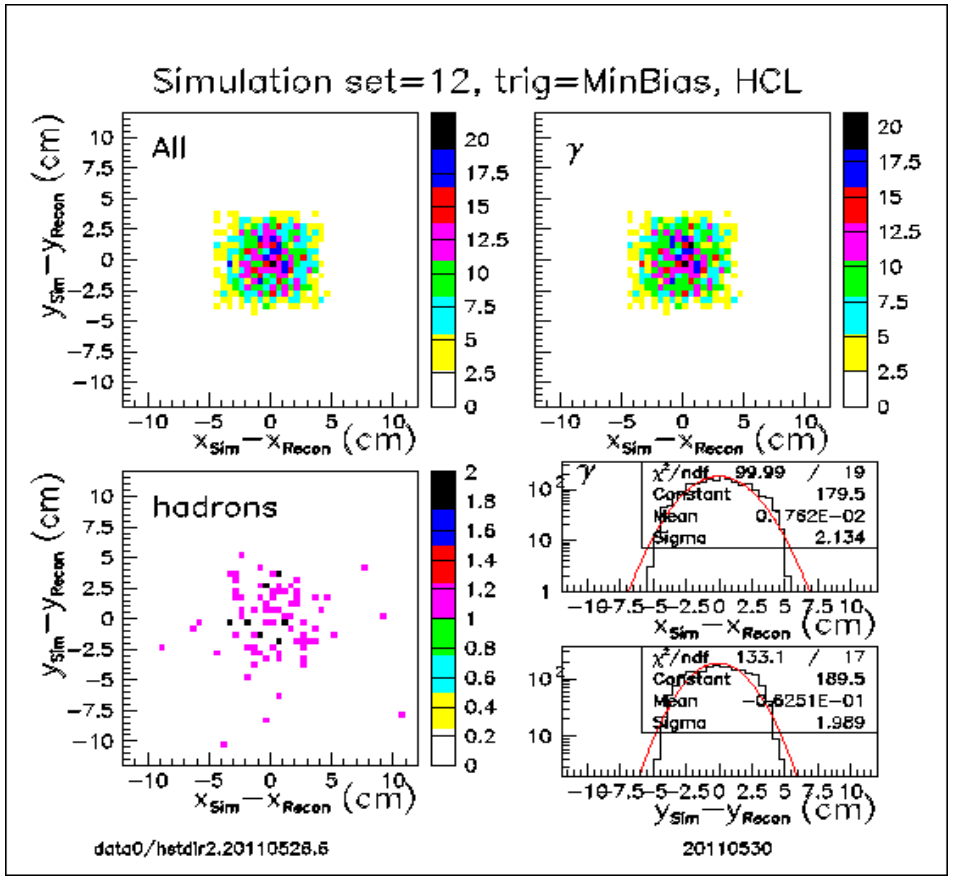


In recent analysis, after BBC efficiency correction, A_NDY get ~ 6.5/pb in run11.

Jet analyzing power measurement sets goal of 10 / pb for run 11.

Hadronic calorimeter calibration

- Association studies in PYTHIA+GEANT simulation.



- Associations for clusters requiring:

(1) 1-tower clusters;

(2) E>1.8 GeV;

(3) |x|>50 cm to avoid ECal shadow;

(4) >1 clusters to form pairs;

(5) E_{pair}>5 GeV;

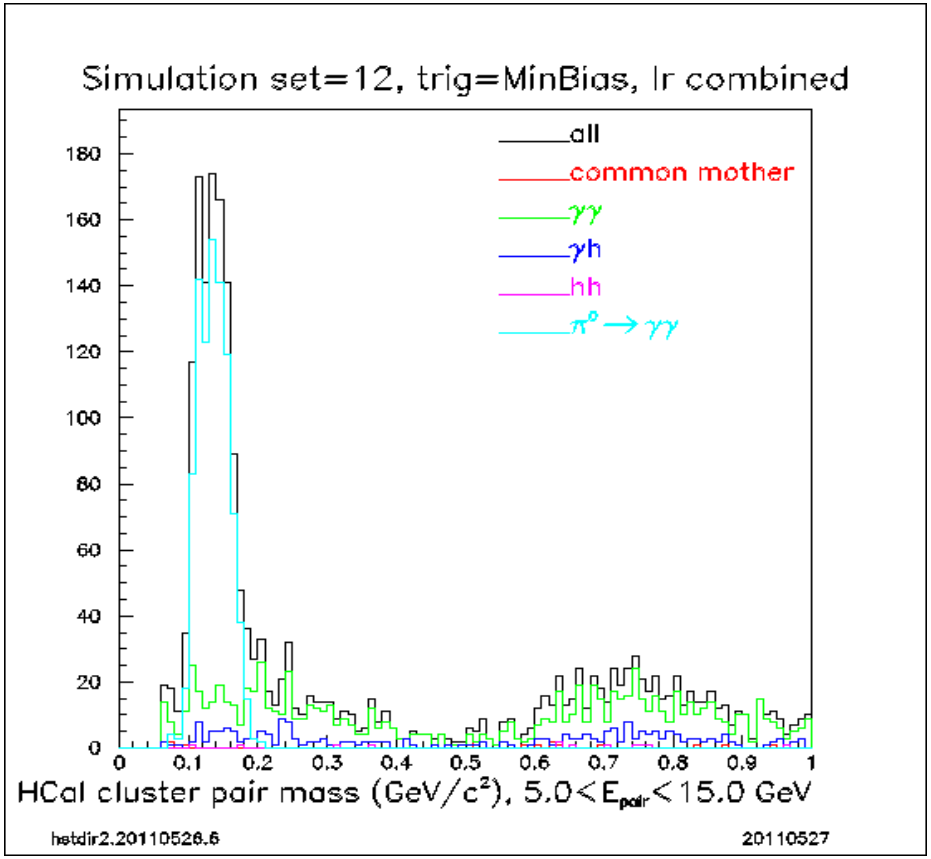
(6) M_{pair}<0.5 GeV;

(7) (6) z_{pair}<0.5.

- Photon position resolution is ~1/5 cell-size.
- Single tower clusters in this energy range are dominated by photons.

Hadronic calorimeter calibration

- Pair mass from photon-like clusters in Hcal (simulation).



- Pair mass is computed subject to the requirements:

(1) 1-tower clusters;

(2) E>1.8 GeV;

(3) |x|>50 cm to avoid ECal shadow

(4) >1 clusters to form pairs;

(5) E_{pair}>5 GeV;

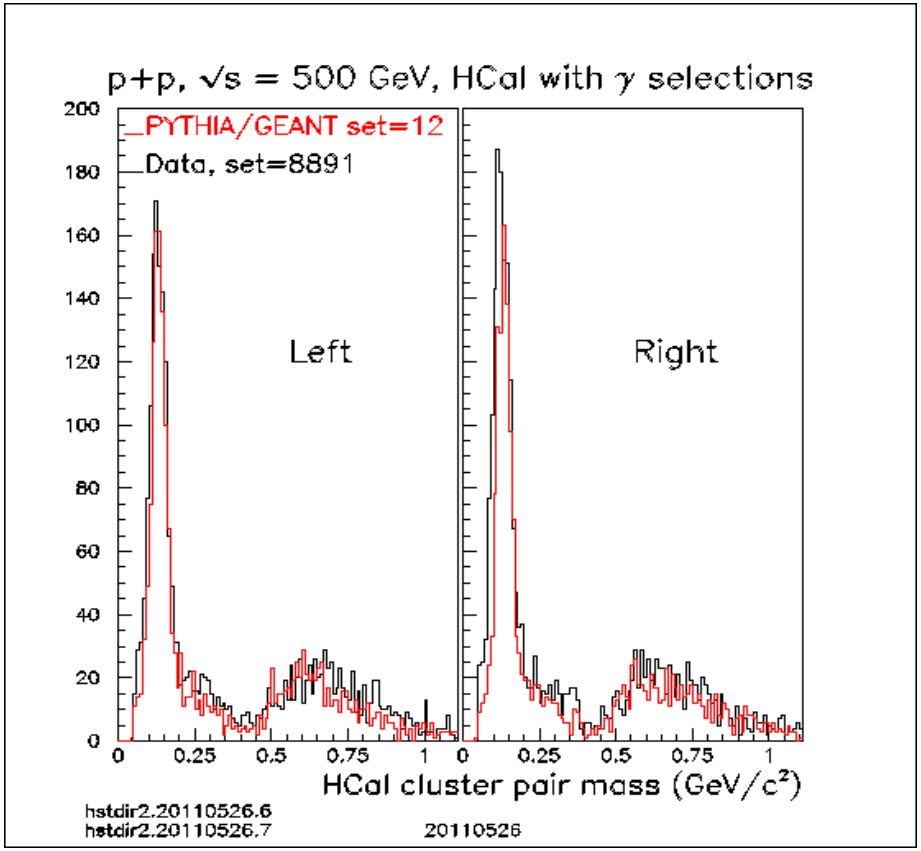
(6) M_{pair}<0.5 GeV;

(7) z_{pair}<0.4.

916/1245 events with M_{pair}<0.22 GeV/c^2 are from $\pi^0 \rightarrow \gamma\gamma$ pairs.

Hadronic calorimeter calibration

- Data & simulation intercomparison.



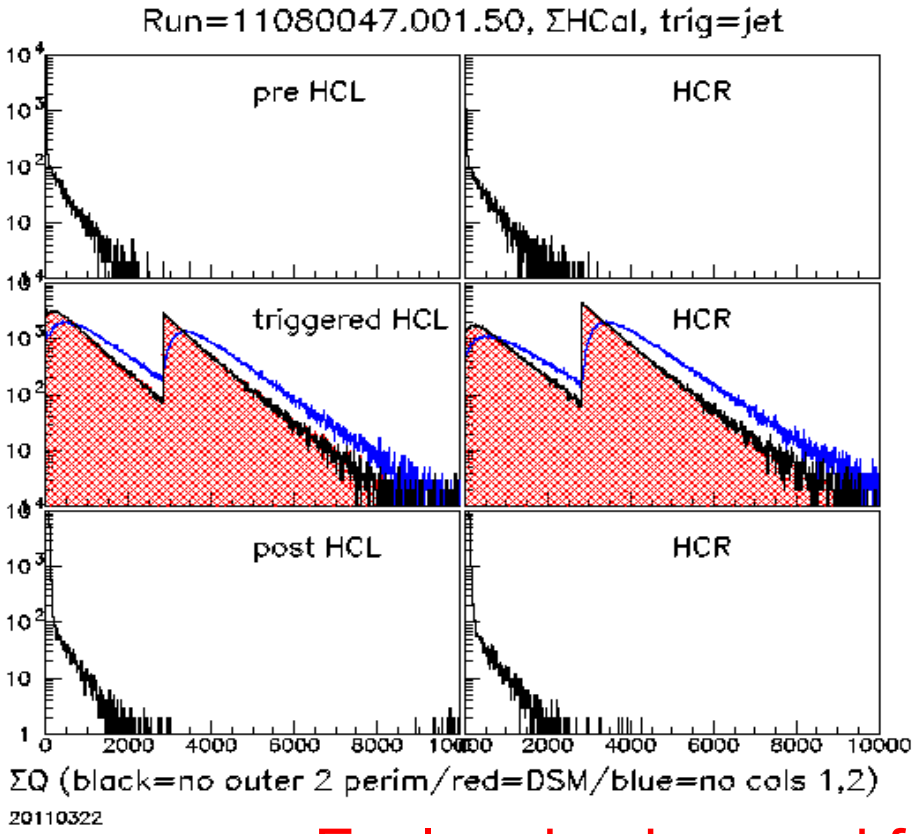
- 20M BBC collision data and 20M simulations events.
- Requirements:

  (1) 1-tower clusters; (2) E>1.8 GeV; (3) |x|>50 cm to avoid ECal shadow; (4) >1 clusters to form pairs; (5) E_{pair}>5 GeV; (6) M_{pair}<0.5 GeV; and (7) z_{pair}<0.5.
- Hadronic response also under study with prospects for $\rho^{\pm}\rightarrow\pi^{\pm}\pi^{0}$ and $\omega\rightarrow\pi^{+}\pi^{-}\pi^{0}$ to correct h/γ differences

Data and simulation are in good agreement.

Run11 jet studies

- Jet-trigger data in Run11.
- Hadronic calorimeter installed at A_NDY makes full jet reconstruction possible.



Hcal ADC Sum pre-crossing jet-trigger data.

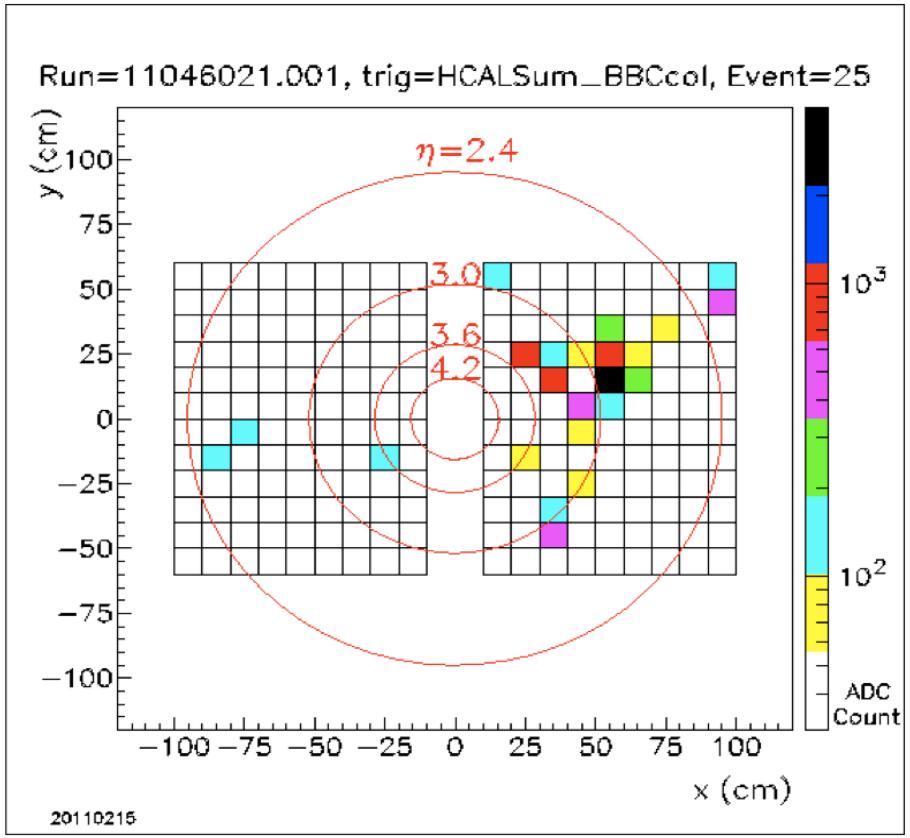
Hcal ADC Sum with jet-trigger
Black: exclude 2 outer perimeters
Blue: exclude 2 beam close columns.

Hcal ADC Sum post-crossing jet-trigger data.

Explore background free jets !

Run11 jet studies

- Hcal jet trigger events.



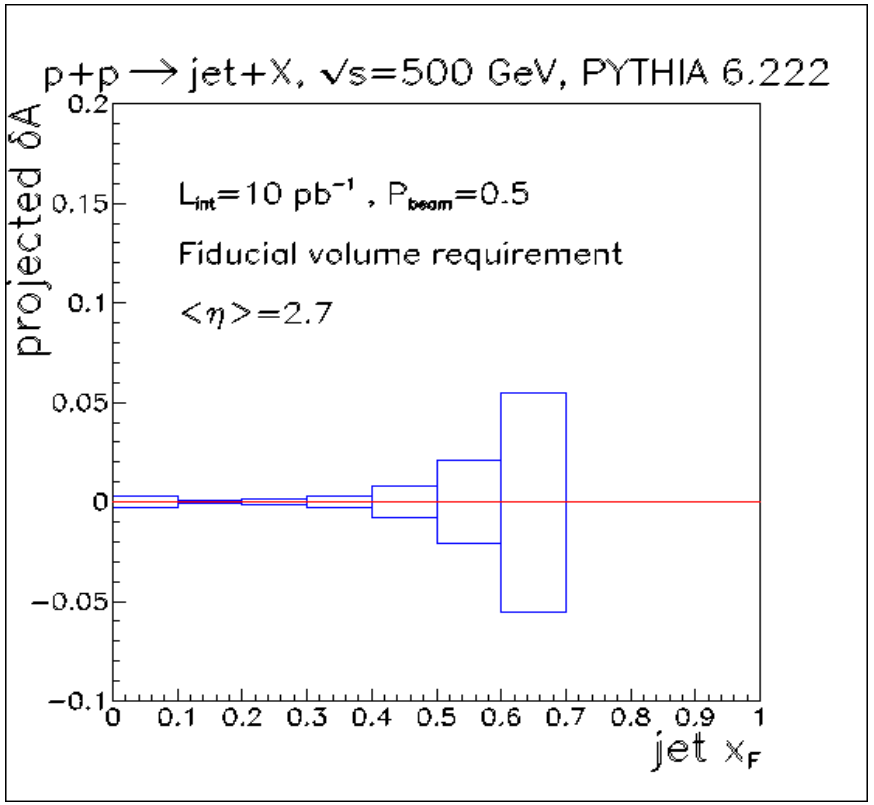
Select from jet trigger events requiring Hcal high tower to be centered in the module.

The events look quite jetty.

More than 750M jet triggered events are recorded during RHIC Run11 polarized p+p collisions.

Run11 jet A_N projection

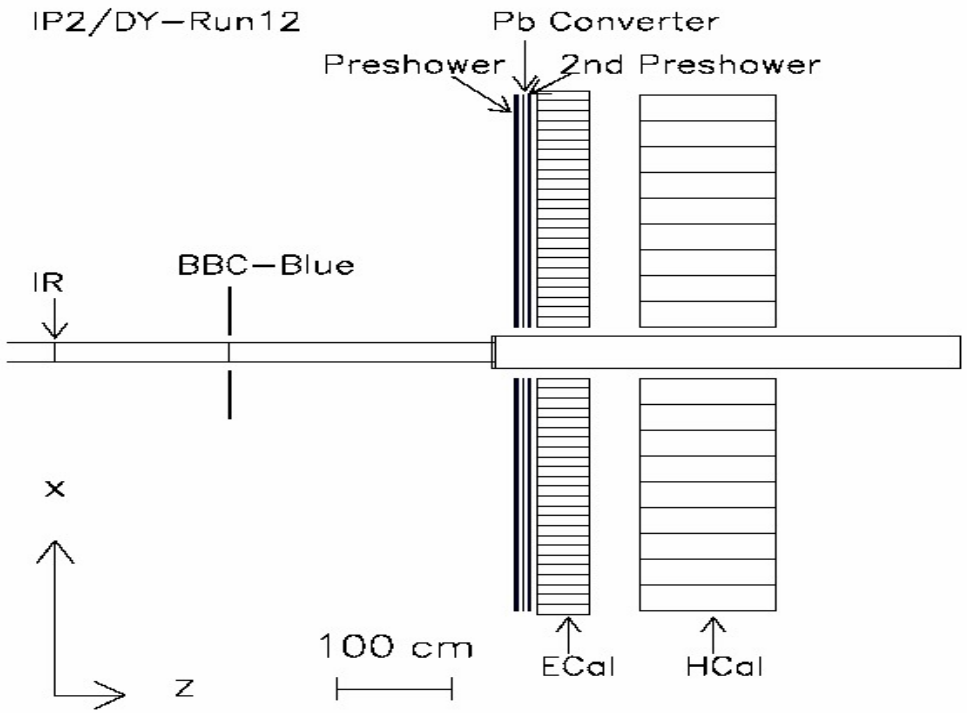
- Run11 jet analyzing power projection
- With ~10/pb & P=50%, AnDY run11 can measure A_N(Jet).



Non-zero A_N(jet) essentially a prerequisite before processing Drell-Yan process.

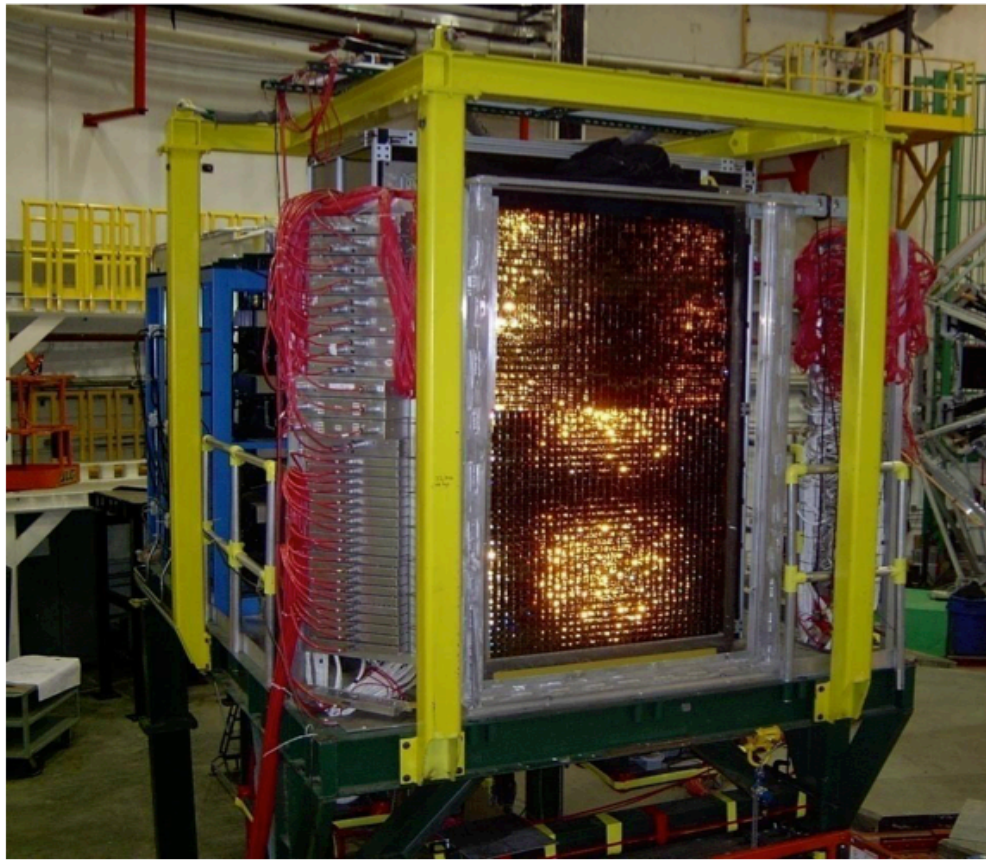
Run12 plan

- A_NDY run12 configuration.



Run12 plan

- EM calorimeter redesign



This is a picture of BigCal from a talk by Vina Punjabi at the Hall A collaboration meeting in June, 2010.

Protvino Glass
32 column × 32 row submatrix
38mm × 38mm ×45cm
TF1 glass from IHEP

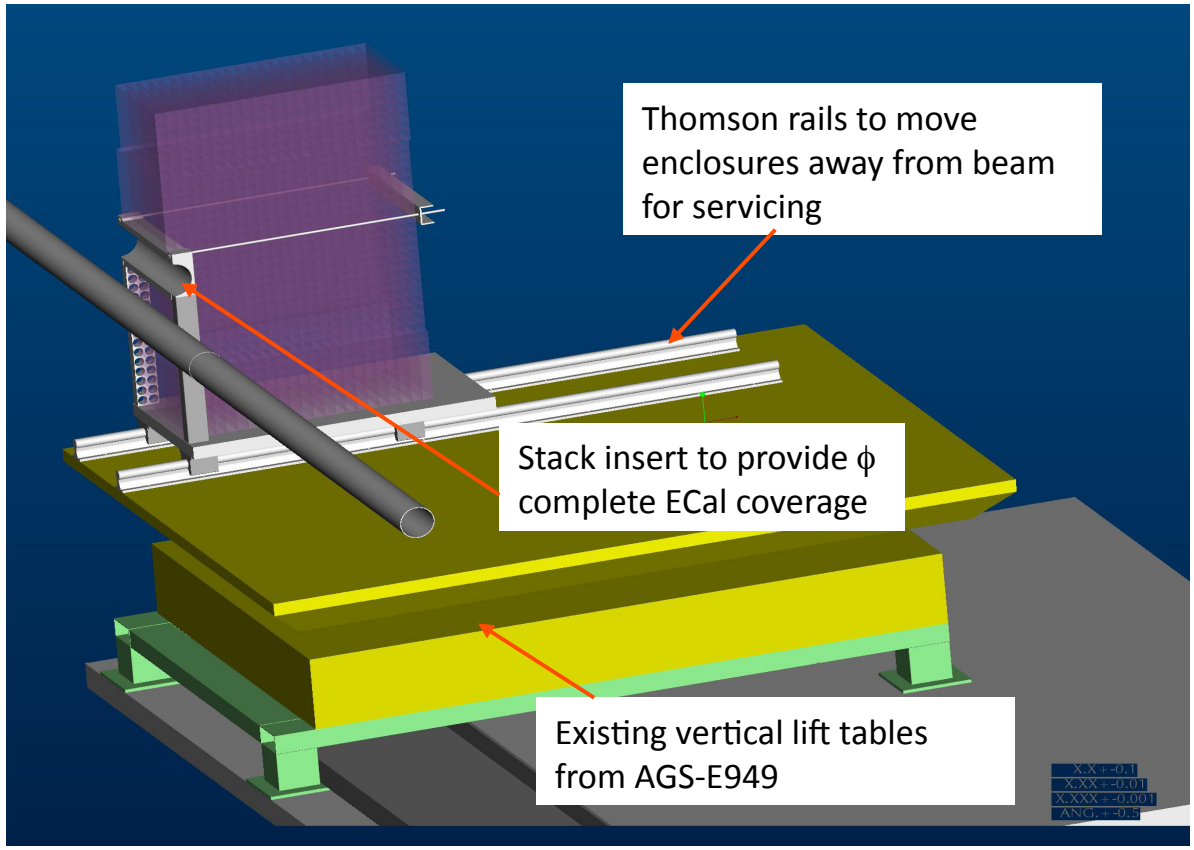
Yerevan Glass
30 column × 24 row submatrix
40mm × 40mm × 40cm
TF1 glass from Yerevan Physics Institute.

120 Yerevan Glass cells already at A_NDY and 98 cells have been used in run11.

Plan to complete moving BigCal to BNL by end of July, with first trip on June 28.

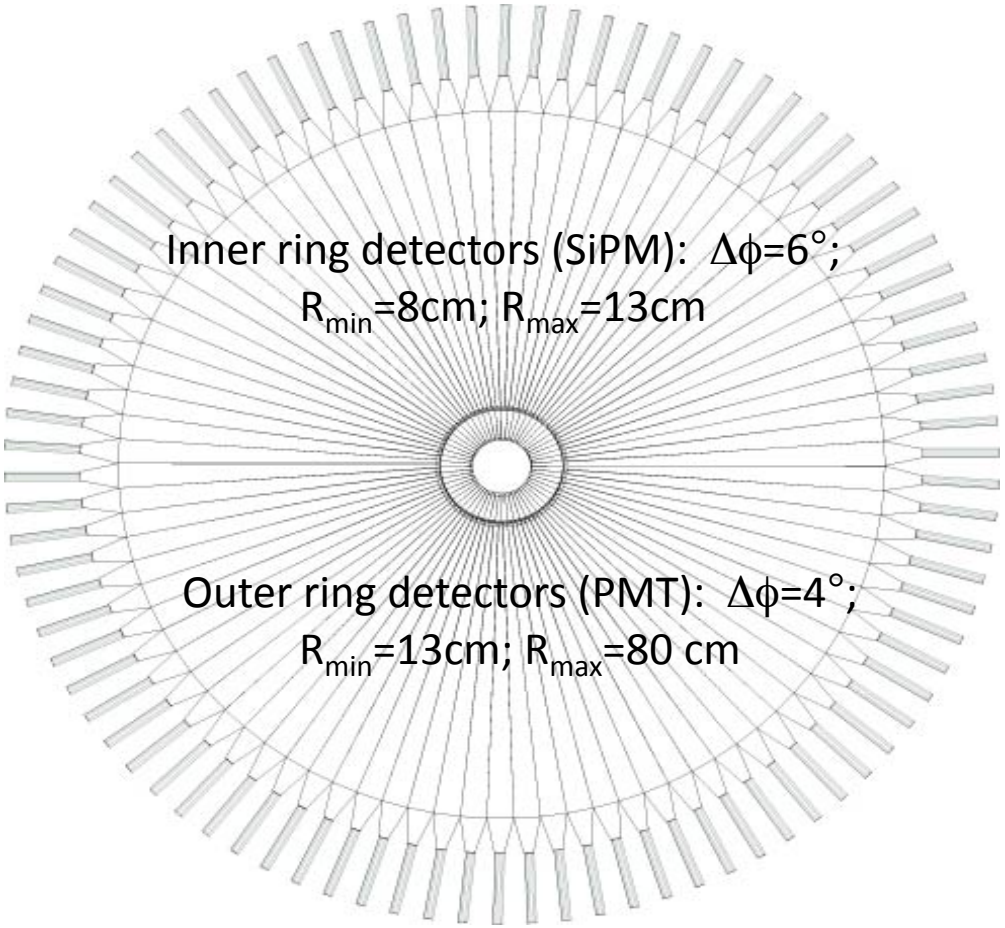
Run12 plan

- Stack EM calorimeter with lead glass from “Bigcal”.
- Azimuthal coverage of EM calorimeter designed by C. Folz.



Run12 plan

- A preshower concept for run12.



$e^{\pm}$/h/γ discrimination relies heavily on preshower detectors (PSD) and converter for longitudinal shower profiling.

Summary

- A_NDY is the first attempt to access forward rapidity Drell-Yan process at $\sqrt{s} = 500GeV$ polarized p+p collisions at RHIC.
- Jet analyzing power measurements in Run11.
- The run11 goals have been met at A_NDY.
- Signed agreement to move Bigcal from JLAB to A_NDY.
- PAC approval for A_NDY.

Summary

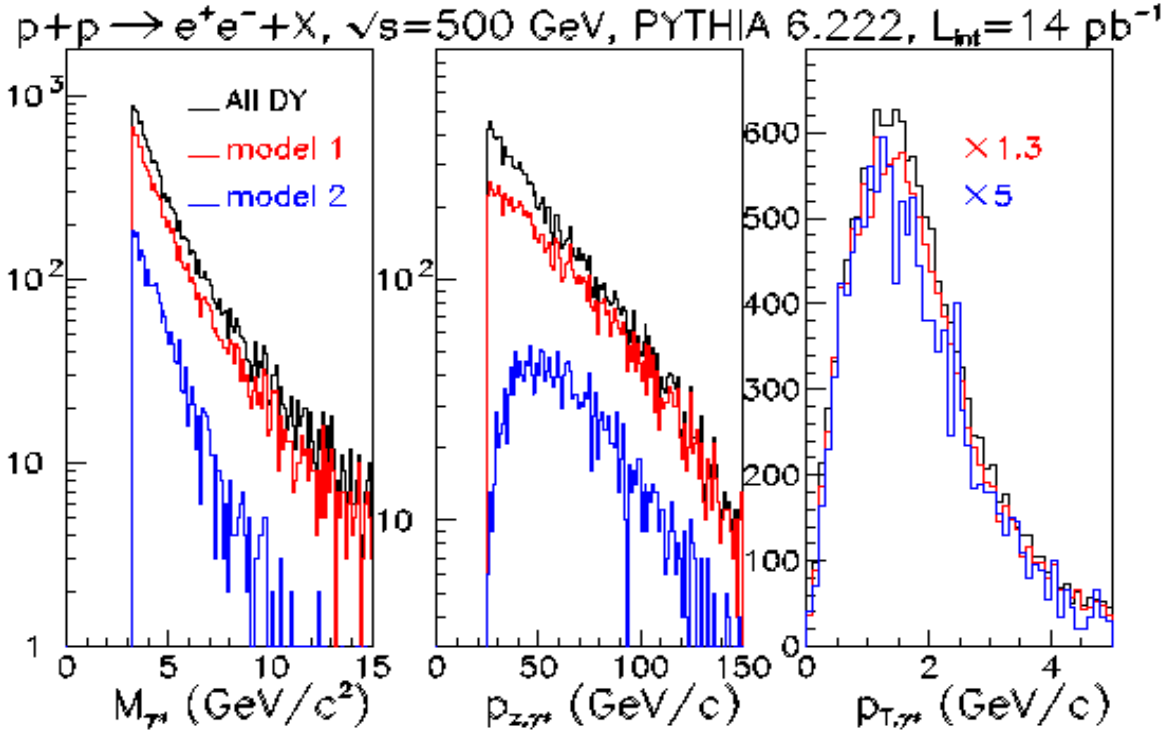
- A_NDY is the first attempt to access forward rapidity Drell-Yan process at $\sqrt{s} = 500GeV$ polarized p+p collisions at RHIC.
- Jet analyzing power measurements in Run11.
- The run11 goals have been met at A_NDY.
- Signed agreement to move Bigcal from JLAB to A_NDY.
- PAC approval for A_NDY.

Outlook

- Run12 100 pb^{-1} luminosity are distributed at A_NDY.
- To observe J/ψ,ϒ and dilepton continuum between them as the benchmark of the DY process.
- Drell-Yan events!

Backup

- e+e- DY expectations at large x_F at $\sqrt{s}$=500 GeV



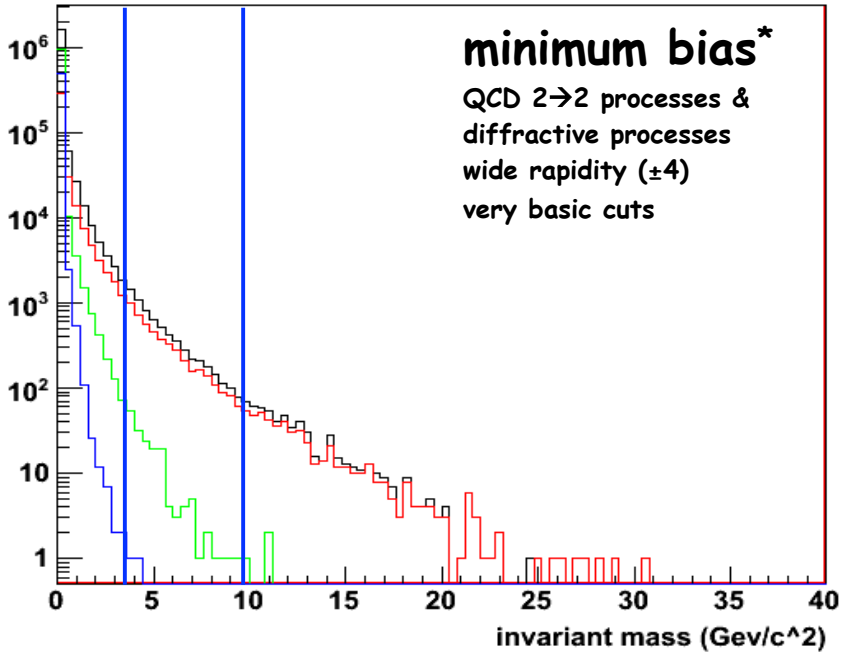
Model 1 = EMcal $(2m)^2$ / $(0.2m)^2$ beam hole at 10m / no magnetic field

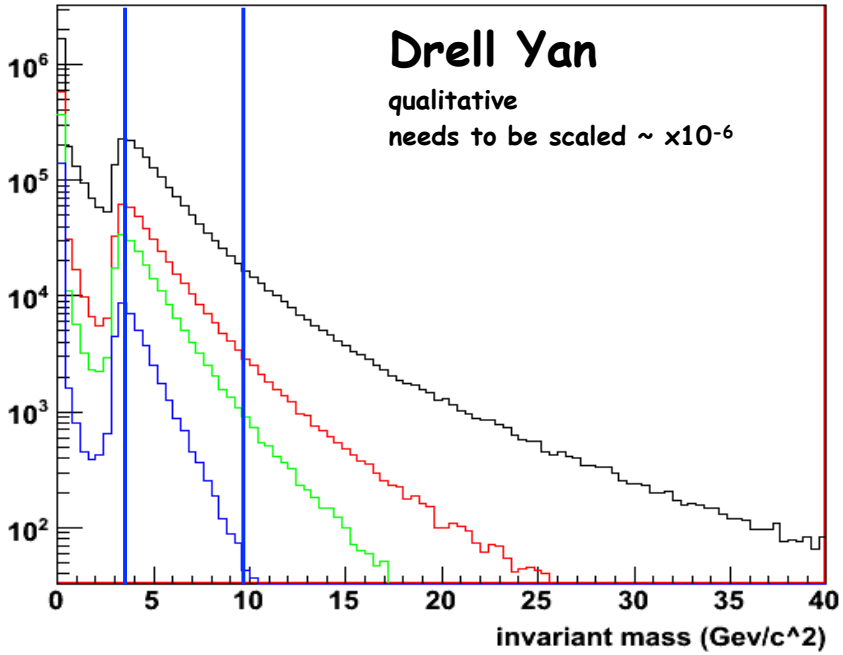
Model 2 = L/R modular EMcal (0.9mx1.2m) at 5m / no magnetic field

√s=500 GeV Simulation

Electron pairs in different rapidity ranges

central (|y|<1), forward (|y|>2), very forward (|y|>3)



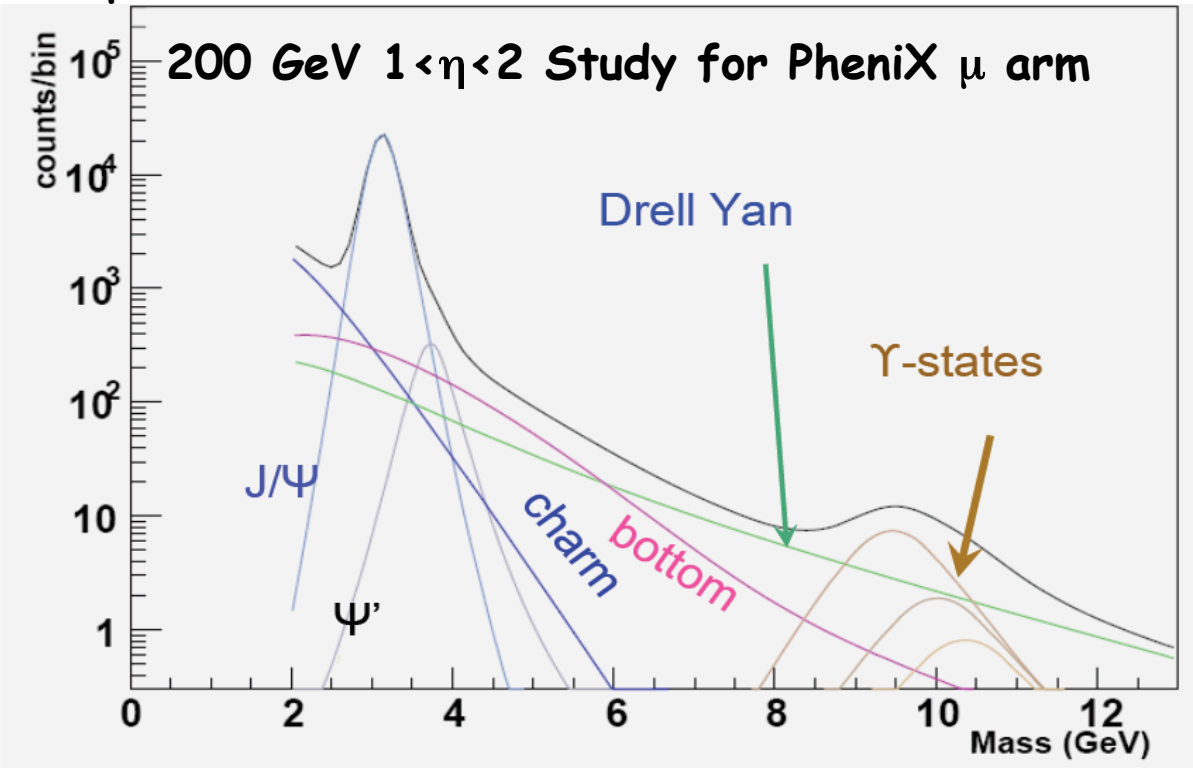


Background decreases faster than signal at forward η

What are the biggest background contributions?

Background to e+e- DY pairs:

- hadronic background from QCD 2→2
  - →$h^{\pm}/e^{\pm}$ discrimination – requires estimates of p+p collisions and EMcal response
  - → charged/neutral discrimination
- photon conversion in beam-pipe and other material
- Open Beauty
- Open Charm



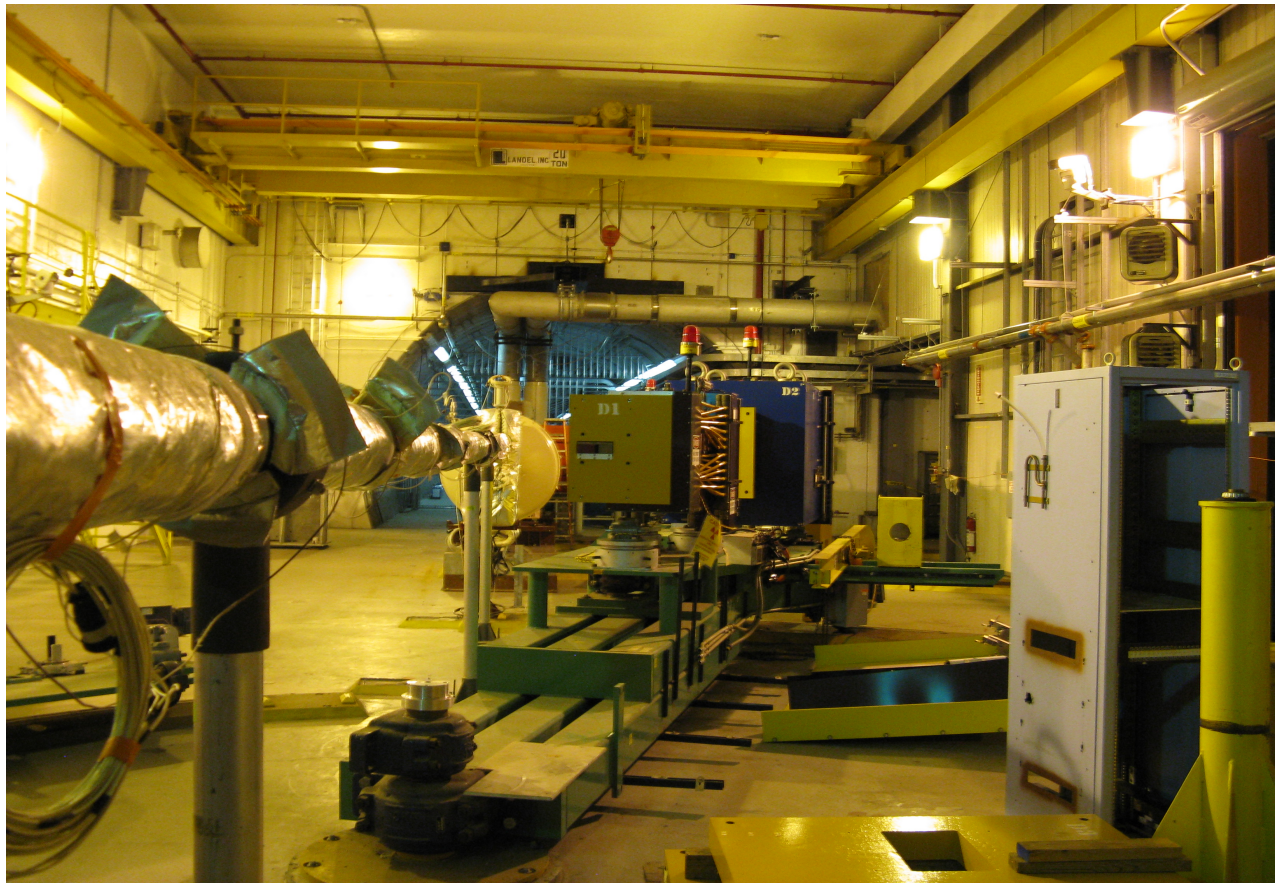
Charm even further reduced going to $\eta > 3$

Transverse Spin Drell-Yan Physics at RHIC (2007)

http://spin.riken.bnl.gov/rsc/write-up/dy_final.pdf

Backup

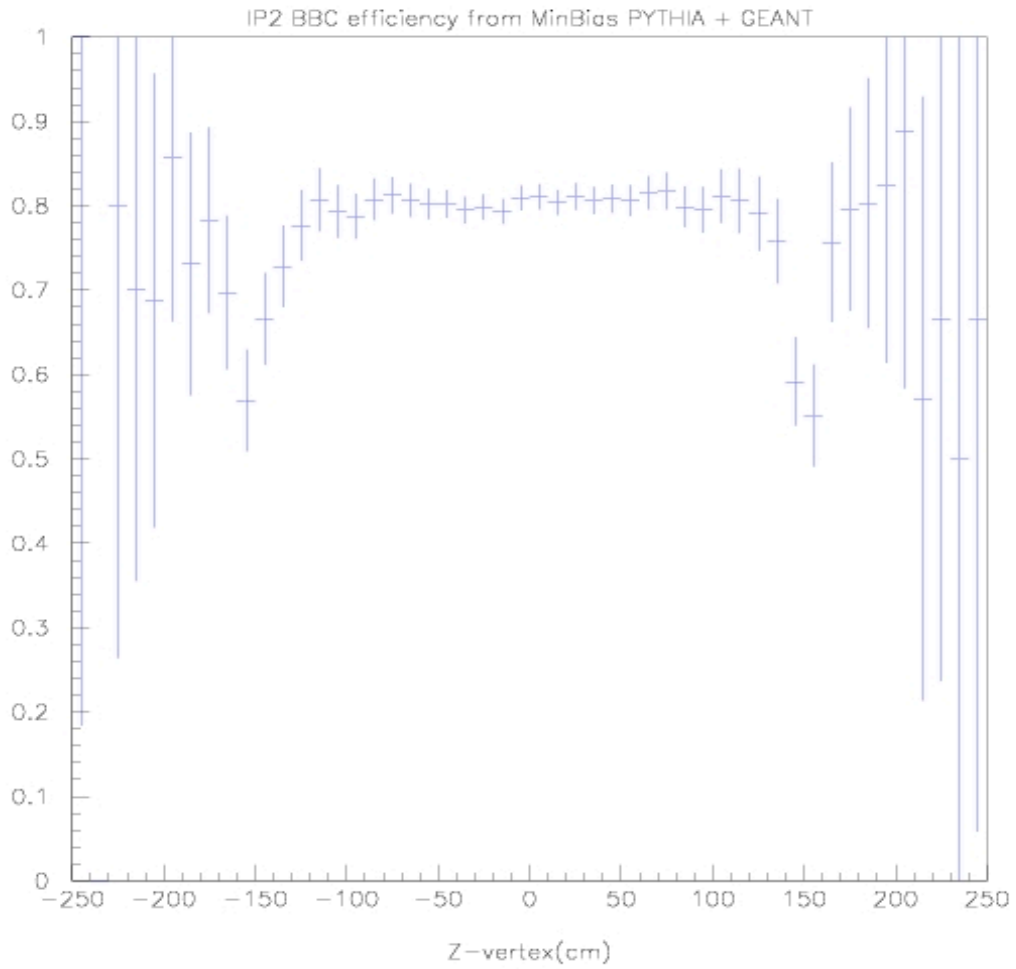
- Aug. 2010 to Jan. 2011



IP2 area (previous BRAHMS experiment), Aug. 2010

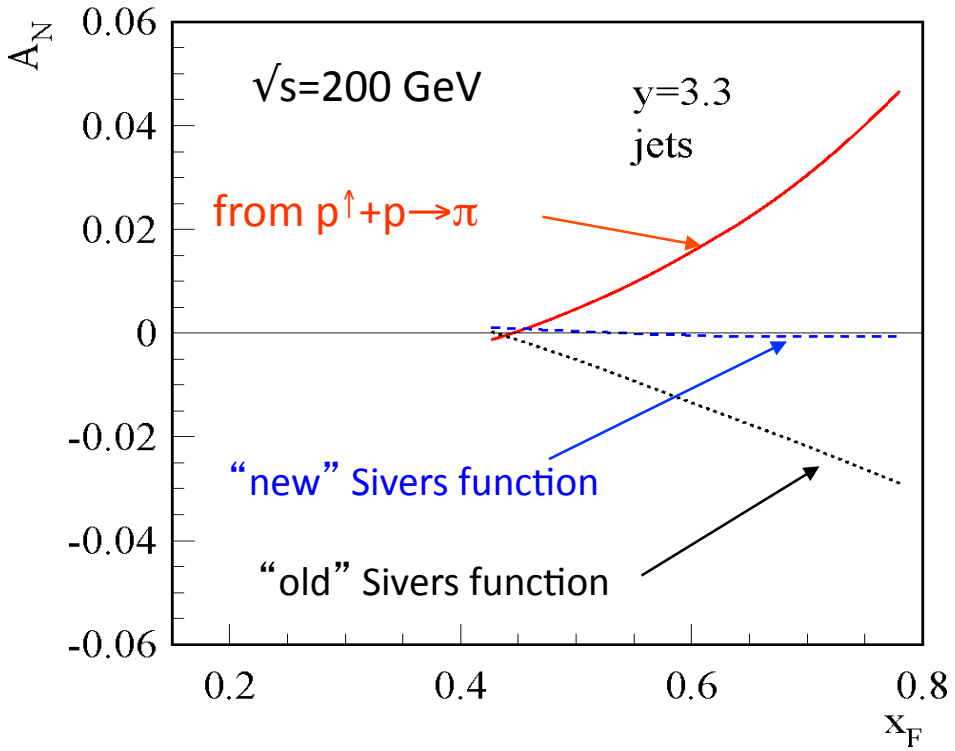
Backup

- BBC efficiency from MB PYTHIA+GEANT simulation



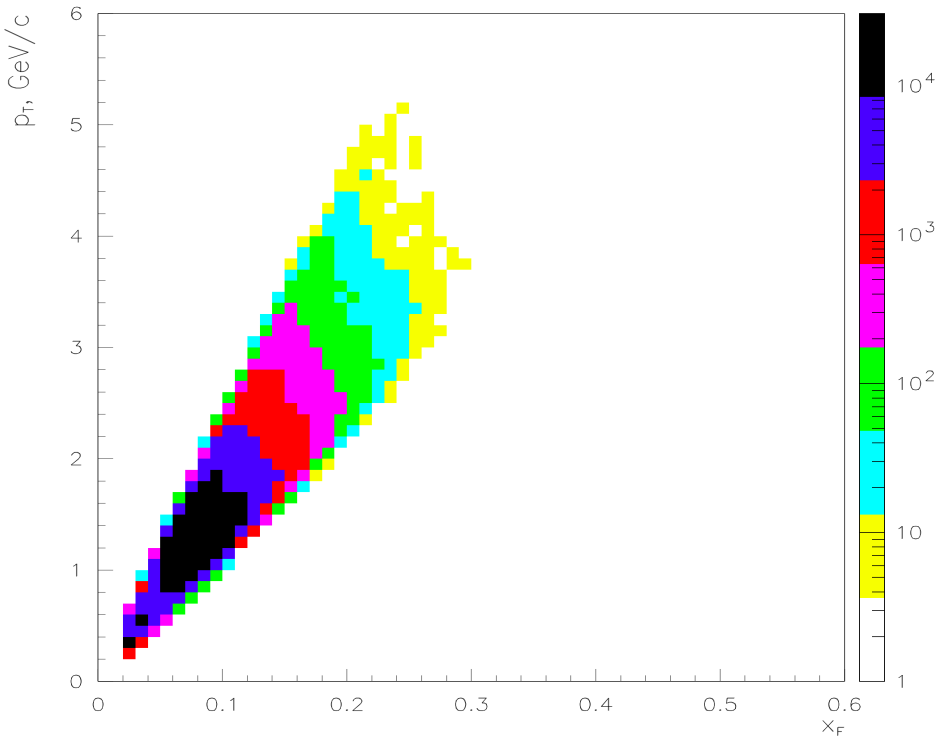
Backup

Z.B.Kang, J.W.Qiu, W.Vogelsang and F.Yuan Phys.Rev.D 83,094001



Backup

- A_NDY EM calorimeter π^0 x_F coverage



E_{tot} > 5 GeV,
N_γ >= 2,
$Z_{\gamma\gamma}$ < 0.8,
FV cut within ½ cell.